I1-025

July 28, 1997

Ms Kate Hansel
CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, CA 95814

Dear Ms Hansel:

We appreciate the opportunity to provide the Inquiry Submittal, "Pilot-Scale Subsurface Flow Wetlands for Selenium Reduction in Agriculture Drainwater," in response to the CALFED Category III Request for Proposals. Ten copies of the submittal are enclosed. We understand that the submittal will be reviewed by CALFED staff to assess the consistency of the project concept with Category III goals. Comments on the submittal may be sent to Harry Ohlendorf, CH2M Hill, 2485 Natomas Park Drive, Ste. 600, Sacramento CA 95833. If questions arise during the review process, I may be reached at (916) 920-0300. Thank you.

Sincerely,

Kathy E-T for

Harry Ohlendorf Ph. D.
Enclosures

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Project Title and Applicant Name: Pilot-Scale Subsurface Flow Wetlands for Selenium Reduction in Agricultural Drainwater; Lawrence Berkeley Laboratory (LBL); and University of California, Riverside (UCR);CH2M Hill, 2485 Natomas Park Drive, Ste 600. Sacramento CA 95833.

Project Description and Primary Biological/Ecological Objectives: This project would design, construct, and evaluate a pilot-scale subsurface flow (SSF) treatment wetland to reduce selenium levels in subsurface agricultural drainage discharged to the San Joaquin River from the Westside of the San Joaquin River Basin. (The technology also could be applied to the treatment of subsurface drainage being impounded and evaporated in the Tulare Lake Basin.) The treatment process would focus on reducing the overall loading of selenium into the aquatic ecosystem, as well as the reduction of selenium concentrations in drainwaters being impounded or discharged. The pilot-scale wetlands could be established either within existing treatment cells at the former Los Banos De-salting Facility (located adjacent to the San Luis Drain) or at a field site (sump or drain) having a high concentration/loading contribution of selenium. The pilot-scale wetland study would provide data to design full-scale treatment wetlands that can be used in selenium-contributing areas. In addition, this study would compare the relative ecological risks associated with SSF treatment wetland to those of surface flow (SF) treatment wetland technology (such as that being proposed by others for CALFED funding, or the system operating within TLDD).

A preliminary conceptual design for such a SSF wetland is shown in the attached figure. The wetland would consist of gravel beds that serve as the rooting medium for salt-tolerant emergent wetland plants (such as bulrush), with the agricultural drainage water flowing through the gravel. As the water flows through the gravel bed, oxidation-reduction processes in the plant root zone (especially due to the interactions of the microbial community and the plant roots) would remove selenium through a combination of uptake and volatilization. These processes are well understood for treatment of conventional pollutants in wastewater (Kadlec and Knight 1996), and the same principles, coupled with knowledge about the oxidation-reduction cycling and volatilization of selenium (e.g., Frankenberger and Karlson 1994, Oremland 1994, Terry and Zayed 1994), could be applied to treatment of selenium in agricultural drainage water.

Approach/Tasks/Schedule: The approach/tasks for this project would be to:

- Design and construct a pilot-scale SSF wetland system;
- Monitor the effectiveness of the SSF wetland system (including quantifying the mechanisms of selenium removal in the treatment wetlands; determining the overall selenium-removal efficiency of three different SSF treatment design options; and evaluating the potential use of specific bacteria, such as *Enterobacter cloacae* Strain SLD1a-1 [which has been isolated from agricultural drainage water and has been shown to effectively reduce selenate with little or no inhibitory effects from the presence of nitrates that present a problem in some removal processes], to bioremediate selenium in agricultural drainage water systems);
- Evaluate risks to ecological receptors due to selenium in the wetland and prepare a comparative ecological risk evaluation for the SSF and SF treatment systems; and
- Integrate the selenium-removal and selenium-risk information to compare SSF treatment wetlands to SF treatment wetlands based on the pilot-scale studies; and provide information needed to develop full-scale SSF treatment wetlands design criteria.

The schedule for the project would be 6 to 12 months for design and construction, followed by 2 or 3 years of monitoring and evaluation, including implications for full-scale system design.

Justification for Project and Funding by CALFED: Subsurface agricultural drainage from the Westside of the San Joaquin River Basin contributes loading of selenium and other constituents to the River, its tributaries, and the Delta. The discharge of selenium is considered to be one of the

most important water quality problems for the San Joaquin River Basin. Constructed SSF treatment wetlands can be used to remove selenium from irrigation drainage water in a manner similar to the treatment of other wastewaters for removal of nitrates and other constituents. These SSF treatment wetlands systems would be especially effective where selenium concentrations and loadings are high. The treatment goal would be to reduce by 50 percent the selenium concentration in the treated water and to lower equivalently the overall loading of selenium from that source to the Bay-Delta system. This treatment goal should be achievable by developing a treatment system that can be constructed for use at individual sumps or agricultural drains so the loss of arable land would be minimized. Other advantages of SSF treatment wetlands are that they reduce the potential for an aquatic food chain pathway for selenium exposure to fish or birds, and the treatment wetlands require only relatively low-cost maintenance after they are in operation.

Budget Costs and Third Party Impacts: Total costs for the project are expected to range between $250,000 and $500,000, depending on the location and size of the SSF treatment wetland and on the intensity of monitoring for evaluation of the system.

Applicant Qualifications: The applicant team includes three individuals who have been actively involved in the selenium-agricultural drainage issues throughout the past decade or longer: Dr. Harry Ohlendorf (CH2M HILL) would serve as team leader; Dr. Sally Benson (LBL) would lead the selenium monitoring effort; and Dr. W.T. Frankenberger (UCR) would lead the microbial characterization tasks. Dr. R.L. Knight (CH2M HILL) would serve as senior consultant on wetland treatment design. These individuals and the firm/institutions of which they are a part have conducted research and provided support to various agencies on a broad range of issues concerning selenium management issues in the San Joaquin Valley and Bay-Delta system.

Monitoring and Data Evaluation: Existing data on chemical, physical, and hydraulic conditions would be collected for the site and water source, because they will influence design. Monitoring would be conducted in accordance with a detailed monitoring plan when the pilot wetland system has been constructed to assure that data collected will be useful for assessing the efficiency of selenium removal. Monitoring of the SSF wetland (including selenium in biota) would be coordinated to the degree possible with any concurrent SF wetlands that are operating to facilitate comparison of the two systems. The selenium removal and ecological risk information would be integrated into a comprehensive comparison of the two treatment systems. In addition, data collected in accordance with the monitoring plan would be evaluated to determine final design criteria for full-scale SSF treatment wetlands.

Local Support/Coordination with other Programs/Compatibility with CALFED objectives: Local support/coordination has not been completely arranged, although some preliminary contacts have been made with irrigation districts. If the SSF wetland system is constructed at the former Los Banos De-salting Facility, the project would be coordinated and evaluated in parallel with other projects proposed by LBL for that site. The proposed project is thoroughly compatible with CALFED objectives.

References

Frankenberger, W.T., Jr., and U. Karlson. 1994. Microbial Volatilization of Selenium from Soils. Pages 369-387 in W.T. Frankenberger Jr. And S. Benson (Eds.) *Selenium in the Environment*. Marcel Dekker, Inc., New York.

Kadlec, R.H., and R.L. Knight. 1996. *Treatment Wetlands*. Lewis Publishers, Boca Raton, FL.

Oremland, R.S. 1994. Biogeochemical Transformations of Selenium in Anoxic Environments. Pages 389-419 in W.T. Frankenberger Jr. And S. Benson (Eds.) *Selenium in the Environment*. Marcel Dekker, Inc., New York.

Terry, N., and A.M. Zayed. 1994. Selenium Volatilization by Plants. Pages 343-367 in W.T. Frankenberger Jr. And S. Benson (Eds.) *Selenium in the Environment*. Marcel Dekker, Inc., New York.

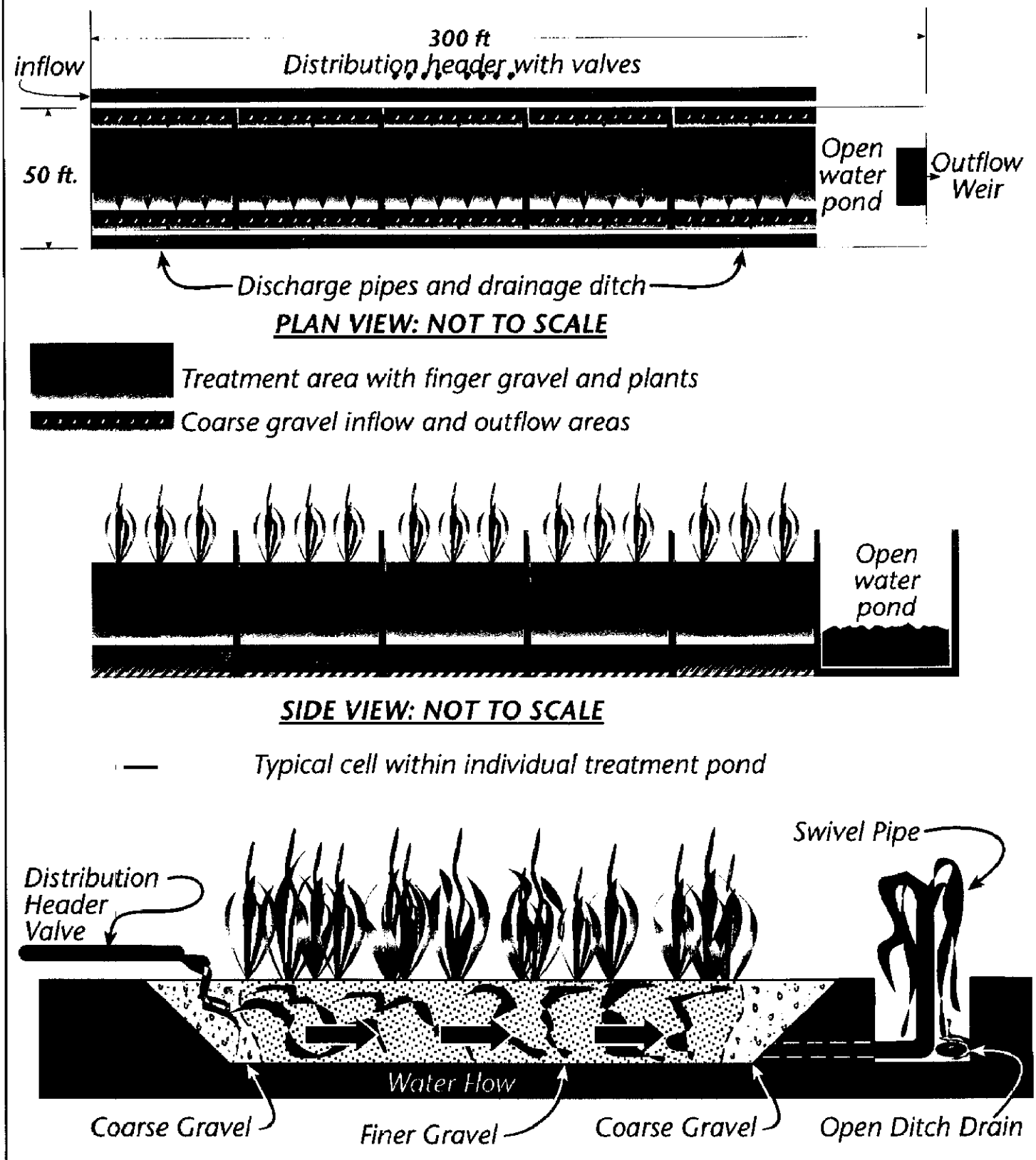

Figure 3
Preliminary Conceptual Design for Subsurface Flow Wetlands
Individual Treatment Pond with 5 Cells in Parallel

Los Banos Quadrangle California-Merced Co.
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